Pathophysiology of Diabetes

Diabetes is a chronic metabolic disorder in which the body cannot metabolize carbohydrates, fats, and proteins because of a lack of, or ineffective use of, the hormone insulin. Diabetes is classified into three primary types that are different disease entities but share the symptoms and complications of hyperglycemia (high blood glucose).

Impaired glucose tolerance, formerly known as "borderline diabetes" is a degree of hyperglycemia that may precede type 2 diabetes.

I. Type 1 (previously called insulin dependent diabetes mellitus (IDDM) or juvenile-onset diabetes)

A. Causes

1. Genetic predisposition.
2. Environmental exposure: virus, toxin, stress.
3. Autoimmune reaction: beta-cells that produce insulin in the pancreas are destroyed. When 80-90% of the beta-cells are destroyed, overt symptoms occur.

B. Characteristics

1. Usually occurs before 30 years of age, but can occur at any age. Peak incidence occurs during puberty, around 10-12 years of age in girls and 12-14 years in boys.*
2. Abrupt onset of signs and symptoms of hyperglycemia: increased thirst and hunger, frequent urination, weight loss, and fatigue.
3. Ketosis prone.

C. Treatment

1. Insulin by injection with syringes or pumps
2. Diet
3. Exercise
4. Education
5. Monitoring

II. Type 2 (previously called non-insulin-dependent diabetes mellitus, NIDDM, or adult-onset diabetes)

A. Causes

1. Insulin resistance: unable to utilize insulin that the body makes because of cell-receptor defect; glucose is unable to be absorbed into cells for fuel.
2. Decreased insulin secretion: pancreas does not secrete enough insulin in response to glucose levels.
3. Excess production of glucose from the liver: result of defective insulin secretory response; dawn phenomenon (see glossary) is an example.

B. Characteristics

1. Usually occurs after 30 years of age, but is now occurring in children and adolescents.
2. Increased prevalence in some ethnic groups, e.g., African Americans, Hispanic/Latino, Native Americans, Asian Americans, and Pacific Islanders.
3. Strong genetic predisposition.
4. Frequently obese.
5. Not prone to ketoacidosis until late in course or with prolonged hyperglycemia.
6. May or may not have symptoms of hyperglycemia.
7. May also have extreme tiredness, blurred vision, delayed healing, numbness and tingling of hands and feet, recurring yeast infection.
8. Children between the ages of 10-19 that have one or more of the following are at an increased risk:
   - Family history
   - Member of certain ethnic populations listed above in B.2.
   - Overweight
   - Sedentary lifestyle

* Source: American Diabetes Association. Diabetes Facts. November, 2003.

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- Pre-puberty.
- Signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans [dirty-neck syndrome], hypertension [high blood pressure], dyslipidemia [lipoproteins inbalance], polycystic ovarian syndrome [PCOS]).

C. Treatment

1. Diet/weight management
2. Exercise/increase physical activity
3. Oral hypoglycemic/antihyperglycemic agents, insulin sensitizers, or insulin
4. Education
5. Monitoring
6. Treatment of comorbid conditions (e.g., hypertension, lipid abnormalities)

III. Gestational Diabetes Mellitus (GDM)

A. Causes

1. Insulin resistance due to pregnancy
2. Genetic predisposition

B. Characteristics

1. Carbohydrate intolerance during pregnancy identified via 1-hour screen using a 50-g oral glucose load (performed between 24th and 28th week of gestation unless otherwise indicated). If the 1-hour screen for glucose is ≥140 mg/dl (≥7.8 mmol/l), a full diagnostic 100-g, 3-hour oral glucose tolerance test (OGTT) is indicated.

C. Treatment

1. Diet: provide adequate calories without hyperglycemia or ketonemia
2. Exercise: program that does not cause fetal distress, contractions, or hypertension (>140/90 mmHg).
3. Insulin: if unable to consistently maintain blood glucose ≤95 mg/dl fasting (≤5.3 mmol/l) and ≤140 mg/dl (≤7.8 mmol/l) 1 hour postprandial and ≤120 mg/dl (≤6.7 mmol/l) 2 hours postprandial.

D. Monitoring

1. Blood glucose: required to determine effectiveness of treatment and possible need for insulin. Glucose should be checked fasting and 1-2 hours postprandial.
2. Ketones: test for ketones using first morning urine sample. Presence of ketones may indicate starvation rather than hyperglycemic ketosis.

For more information about the pathophysiology of diabetes, see the American Diabetes Association's 2004 position statement "Diagnosis and Classification of Diabetes Mellitus" *Diabetes Care,* Volume 27, Supplement 1, pages S5-S10.

For more information about the dyslipidemia often associated with diabetes, please see the American Diabetes Association's 2003 consensus statement, "The Management of Dyslipidemia in Children and Adolescents with Diabetes", *Diabetes Care*, Volume 26, number 7, pages 2194-2197.

Both of the above-mentioned articles can be accessed at: http://care.diabetesjournals.org/.

Adapted from: Ballard, A.M., 2000. *Pathophysiology of diabetes.* "The Diabetes Ready-Reference Guide for Health Care Professionals" by the American Diabetes Association.©

Rights of Children with Diabetes in Public Schools

Getting ready for a new school year is demanding. However, if a child has diabetes, the return to school can be even more difficult. Educating school personnel while preparing your child for a new environment can be awesome and overwhelming even when the school administration is supportive. Many parents face school personnel who will not cooperate when trying to arrange for a child's diabetes management during school time. What many parents do not know is that such resistance can, in fact, be illegal.

One of the first legislative steps toward systematically eliminating discrimination against people with disabilities came with the Rehabilitation Act of 1973. Under this law, individuals with disabilities were protected against discrimination in any federally funded program, including the public school system.

Two years later, the Education for All Handicapped children Act of 1975, amended in 1991 and renamed the Individuals with Disabilities Education Act (I.D.E.A.), guarantees a "free, appropriate, public education," including special education and related service programming, to all youth with disabilities who require it.

Many people are not aware that these anti-discriminatory disability laws explicitly cover children with diabetes. All schools receiving federal funds must make reasonable accommodation for the special needs of children with diabetes in order to assure them a "free, appropriate, public education."

In other words, if your child requires snacks in the classroom, freedom to go to the restroom, allowances to participate fully in extracurricular activities without restriction, or any other diabetes-related service, the school is mandated to reasonably accommodate. In fact, I.D.E.A. requires the school to actively seek out children with disabilities, including diabetes, and to work with the parents developing a program that would best suit the child's specific medical needs.

The Department of Education is monitoring the implementation of these various anti-discriminatory education laws. They have scheduled hearings to speak with area advocates about how children with disabilities are being accommodated.

Additional information can be found in the American Diabetes Association's 2006 position statement, "Diabetes Care in the School and Day Care Setting", *Diabetes Care*, Volume 29, Supplement 1, pages S49-55. Retrieved July 13, 2006 from American Diabetes Association website.
http://care.diabetesjournals.org/

Source: "Diabetes Management in the School Setting", 1998, Missouri Association of School Nurses.

Why is Type 2 Diabetes in Children on the Rise?

In 1998, former U.S. Surgeon General David Satcher declared the soaring rate of childhood obesity an epidemic. Data collected by the federal Centers for Disease Control and Prevention (CDC) indicate the prevalence of adult obesity (defined as a body mass index of 25 or more) has soared in the last 30 years.[1] Body mass index (BMI) is a mathematical formula in which a person's body weight in kilograms is divided by the square of his or her height in meters, i.e., wt/ht. Nearly one in five Americans was considered obese in 1998. By 2001, the prevalence of obesity had increased to 20.9%, which was a 5.6% increase from 2000[2]. Although the reasons for the obesity epidemic have not been confirmed, the prevalence of obesity has increased so rapidly, we know its origin is not genetic.[3]

Former U.S. Surgeon General Dr. C. Everett Koop has said that "except for smoking, obesity is now the number one preventable cause of death in this country."[4] Obesity may also be the number one preventable risk factor associated with type 2 diabetes in children and adolescents. According to the American Medical Association, losing weight is the single most effective way to reduce the risk of developing diabetes and to manage it.[5]

A healthy diet and exercise are critical to losing weight. Therefore, it is not surprising that research suggests type 2 diabetes may be preventable through proper nutrition and exercise. These, along with blood glucose monitoring and medication treatment methods, should be fully supported by family and health care professionals.[6]

Although type 2 diabetes is a problem among youth, nationally representative data to monitor diabetes trends among youth are not yet available. In response to the growing public health concerns about both type 1 and type 2 diabetes, the CDC and the National Institutes of Health (NIH) are funding a 5-year study, called the SEARCH study, to examine the current status of diabetes among children and adolescents in the United States.[6] If the SEARCH study accomplishes its goals, it will provide valuable information to researchers and health care professionals about both types of diabetes.

The specific goals of the SEARCH study are:

- To develop a uniform classification of types of diabetes
- To estimate the number of new and existing childhood diabetes cases by type, age of the child, sex, and racial or ethnic group
- To describe the clinical characteristics of different types of diabetes in youth and how they evolve
- To describe the complications of diabetes in children and adolescents
- To describe the quality of life of children and adolescents with type 2 diabetes[7]

Sources:

[1] Centers for Disease Control and Prevention. Defining overweight and obesity. http://www.cdc.gov/nccdphp/dnpa/obesity/

[2] Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS, Marks JS. Prevalance of obesity, diabetes, and obesity-related health risk factors, 2001. JAMA. 2003; 289(1):76-9.

[3] National Center for Chronic Disease Prevention and Health Promotion. *Chronic Disease Notes & Reports, Preventing Obesity Among Children*. Vol 13 No 1, Winter 2000.

[4] Koop CE, as quoted by CNN. The Global Spread of Obesity, January 12, 2000.

[5] American Diabetes Association. Diabetes Type 2: Reducing your risk, 1998, as adapted from Type II Diabetes: Reducing Your Risk, 1996.

[6] Brosnan CA, Upchurch S, Schreiner B. 2001. Type 2 diabetes in children and adolescents: An emerging disease. *Journal of Pediatric Health Care* 15(4):187-193.

[7] Centers for Disease Control and Prevention. Fact Sheet: SEARCH for Diabetes in Youth. December 19, 2002. http://www.cdc.gov/diabetes/pubs/pdf/search.pdf

Type 2 Diabetes in Children and Adolescents

In 1999, the American Diabetes Association convened a consensus development conference on type 2 diabetes in children and adolescents. This development conference was held to assess present understanding and knowledge, as well as provide guidance to health care providers on the medical management of type 2 diabetes in children and adolescents.

The eight-member panel developed a consensus statement on the six following questions:

1. What is the classification of diabetes in children and adolescents?
2. What is the epidemiology of type 2 diabetes in children and adolescents?
3. What is the pathophysiology of type 2 diabetes in children and adolescents?
4. Who should be tested for diabetes?
5. How should children and adolescents with type 2 diabetes be treated?
6. Can type 2 diabetes in children and adolescents be prevented?

A brief summary of this consensus statement is provided below. For the complete consensus statement, go to the American Diabetes Association's website: http://care.diabetesjournals.org/cgi/reprint/23/3/381.pdf

Currently, children with type 2 diabetes are usually diagnosed over the age of 10 years and are in middle to late stage of puberty. As the childhood population becomes increasingly overweight, type 2 diabetes may be expected to occur among younger prepubertal children.

Only those children who are at substantial risk should be tested for type 2 diabetes. The panel recommended if **the child was overweight and had two or more** of the risk factors listed below, testing should be done every 2 years starting at the age of 10 years or at onset of puberty.

- Family history of type 2 diabetes
- Non-European ethnicity/ancestry
- Signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans [also referred to as "dirty-neck" syndrome], hypertension, dislipidemia, etc.)
- Patient age (starting at the age of 10 years or at onset of puberty)

Consider testing in any other high risk patients who display any of the characteristics listed above, **including overweight**.

Primary prevention of type 2 diabetes in children should ideally include a public health approach that targets the general population. Health professionals need to be involved in developing and implementing school- and community-based programs to promote improved dietary and physical activity behaviors for all children and their families. At the com-

munity level, schools, religious organizations, youth and family organizations, and government agencies should assume some responsibility for promoting a healthy lifestyle. Planning of effective preventative efforts for populations at-risk needs to involve members of those at-risk groups.

Source: *Diabetes Care*, 2000 Consensus Statement, Volume 23, Number 3, Pages 381-389, "Type 2 Diabetes in Children and Adolescents", American Diabetes Association.

Acanthosis Nigricans

"Acanthosis Nigricans" (AN) is a skin condition that signals high insulin levels in the body. This skin condition is referred to as a "velvety" hyperpigmented (darkened) skin change, often found on the neck, axilla, groin, and other flexural areas. It is also associated with polycystic ovarian syndrome (PCOS) in which many girls may have AN, along with obesity, irregular menses, acne and hirsutism.

Why is Acanthosis Nigricans Important?

Acanthosis Nigricans can help identify persons who have high insulin levels and who may be at-risk for developing diabetes. Once identified, the necessary measures to lower the insulin levels and reduce the risk of developing diabetes can be taken. Exercise and proper nutrition will help the body become more sensitive to insulin and lower insulin levels.

Scientists have also found that having high insulin levels over long periods of time can increase the risk of the following conditions:

- Cardiovascular disease problems
- Hypertension (High Blood Pressure)
- Increased cholesterol and triglycerides

The Centers for Disease Control (CDC) recognize that, although acanthosis nigricans is a marker for high levels of insulin, it should not be used to predict diabetes and they strongly discourage acanthosis nigricans screening of children in school or community settings.

For more information on CDC's statement, visit their website at http://www.cdc.gov/diabetes/news/docs/an.htm.

Source: "Acanthosis Nigricans – A Sign of the Times", Texas Tech University Health Sciences Center, Edinburg, Texas, 2001.